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Dated

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25 SEP 1993

29 SEP '93 H003C2347

PAT 1 77 UC

25.00

9319832.3

Your reference

JD/MS/G20290

Notes

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The
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Request for grant of a Patent

Form 1/77

Patents Act 1977

1 Title of invention

- 1 Please give the title of the invention
- Improvements Relating to the Lining of Pipelines and Passageways

2 Applicant's details

☐ First or only applicant

- 2a If you are applying as a corporate body please give:

Corporate name

Insituform Technologies Inc

Country (and State of incorporation, if appropriate)

USA

- 2b If you are applying as an individual or one of a partnership please give in full:

Surname

Forenames

- 2c In all cases, please give the following details:

Address

1770 KirbyParkway
Suite 300
Memphis
Tennessee 38138

UK postcode
(if applicable)

Country

USA

ADP number
(if known)

6420301001

RIP

2d, 2e and 2f: If there are further applicants please provide details on a separate sheet of paper.

☐ **Second applicant (if any)**

2d If you are applying as a corporate body please give:

Corporate name

Country (and State
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2e If you are applying as an individual or one of a partnership please give in full:

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③ An address for service in the United Kingdom must be supplied

Please mark correct box

③ Address for service details

3a Have you appointed an agent to deal with your application?

Yes ☒ No ☐ → go to 3b

↓
please give details below

Agent's name Bailey Walsh & Co

Agent's address 5 York Place
Leeds

Postcode LS1 2SD

Agent's ADP
number 224001

3b: If you have appointed an agent, all correspondence concerning your application will be sent to the agent's United Kingdom address.

3b If you have not appointed an agent please give a name and address in the United Kingdom to which all correspondence will be sent:

Name

Address

Postcode

ADP number
(if known)

Daytime telephone
number (if available)

4 Reference number

4 Agent's or
applicant's reference
number (if applicable)

JD/MS/G20290

5 Claiming an earlier application date

5 Are you claiming that this application be treated as having been filed on the date of filing of an earlier application?

Yes ☐ No ☒ ➡ go to 6

↓
please give details below

☐ number of earlier
application or patent
number

☐ filing date
(day month year)

☐ and the Section of the Patents Act 1977 under which you are claiming:

15(4) (Divisional) ☐ 8(3) ☐ 12(6) ☐ 37(4) ☐

6 Declaration of priority

6 If you are declaring priority from previous application(s), please give:

Country of filing	Priority application number (if known)	Filing date (day, month, year)
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6 If you are declaring priority from a PCT Application please enter 'PCT' as the country and enter the country code (for example, GB) as part of the application number.

Please give the date in all number format, for example, 31/05/90 for 31 May 1990.

- 7 The answer must be 'No' if:
- any applicant is not an inventor
 - there is an inventor who is not an applicant, **or**
 - any applicant is a corporate body.

8 Please supply duplicates of claim(s), abstract, description and drawing(s).

Please mark correct box(es)

- 9 You or your appointed agent (see Rule 90 of the Patents Rules 1990) must sign this request.

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A completed fee sheet should preferably accompany the fee.

7 Inventorship

7 Are you (the applicant or applicants) the sole inventor or the joint inventors?

Please mark correct box

Yes ☐

No ☒

➡ **A Statement of Inventorship on Patents Form 7/77 will need to be filed (see Rule 15).**

8 Checklist

8a Please fill in the number of sheets for each of the following types of document contained in this application.

Continuation sheets for this Patents Form 1/77

[Signature]

Claim(s)

Description

Abstract

Drawing(s)

8b Which of the following documents also accompanies the application?

Priority documents (please state how many)

Translation(s) of Priority documents (please state how many)

Patents Form 7/77 – Statement of Inventorship and Right to Grant
(please state how many)

Patents Form 9/77 – Preliminary Examination/Search

Patents Form 10/77 – Request for Substantive Examination

9 Request

I/We request the grant of a patent on the basis of this application.

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Date 24 9 93
(day month year)

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Improvements Relating to the Lining of Pipelines and
Passageways

This invention relates to the lining of pipelines and passageways, using linings which have now become known as "cured in place" linings, which comprise tubular structures comprising or including at least one layer of resin absorbent material which is impregnated with a curable synthetic resin. The tubular structure while impregnated with resin and whilst the resin is uncured, is shaped to the surface which it is to line and held in that position by fluid pressure. Curing of the resin then takes place or is caused to take place, so that the tubular structure will form a rigid layer which remains in place on the surface by virtue of its own rigidity and/or by virtue of bonding to the surface, but in any event an effective lining is provided.

Cured in place systems have been used very successfully for many years for the lining of underground pipelines and passageways, in particular sewer pipes, and examples of cured in place lining systems are disclosed in US Patents and

In these prior patents, it is envisaged that long lengths of main sewer lines will be lined, but in any main sewer line there are what are known as lateral connections which are the side or branch pipes which lead from the sewer to for example domestic consumption points. When a lining is applied along a main sewer as described in said US patents, the tubular structure will cover the lateral connections and these subsequently have to be reopened by the cutting away of coupons of the rigid lining in register with the lateral connections.

It is also been proposed to apply lining tubes in the said

lateral passageways, but for a long time there has been a problem in providing an effective coupling arrangement in the region where the lateral passageway meets the main pipe. Indeed, in many cases it is the lateral/main pipe connection which causes the greatest problem in practice and often in a defective sewer pipe, it is only the lateral/main pipe connections which require to have a cured in place lining structure applied thereto.

When main line linings have been applied, and coupons are cut therefrom, difficulties often remain at the lateral/main pipe connections, and attempts have been made to cure these defects, but generally speaking the procedure is difficult and unsatisfactory.

The present invention seeks to provide a cured in place assembly for a lateral/main pipe connection whereby many of the difficulties at present existing will be overcome.

More particularly, the invention seeks to provide an assembly which can be positioned in the region of a lateral/main pipe connection and by a single operation results in the creation of a cured in place structure forming an effective lateral main pipe seal.

In accordance with the invention in a broadest aspect thereof an assembly for effecting a cured in place lining in the region of a lateral/main pipe connection, comprises a length of tubular structure for application to the main pipe surface to each side of a lateral connection, said length of main pipe tubular structure having a wall aperture for register with the lateral pipe, and a lateral extension tubular structure for extending of the lateral, said lateral tubular structure and main pipe tubular structure being of cured in place type in that each comprises at least one layer of a

resin absorbent material which in use is impregnated with curable synthetic resin.

By providing this assembly, which is in effect a "tailored" unit to be urged into close contact in the region of the lateral/main pipe connection, a simple and effective means is provided for addressing the difficulty of forming a seal in the region of a lateral/main pipe connection.

To interconnect the extension tubular structure and a main pipe tubular structure, the main pipe tubular structure may be initially fabricated and provided with an aperture therein. The extension tubular structure may be provided at one end with a collar and the extension tubular structure is fed through the said aperture in the main pipe tubular structure so that the collar lies to the inside of the main pipe tubular structure. The said collar may be a rigid plastics material collar, or it may be a collar of resin absorbent materials similar to that of the extension tubular structure.

Additionally, it is preferred that there be provided a tailored inflation assembly for the purposes of inflating the main pipe tubular structure and the extension tubular structure simultaneously. The inflation assembly may be made of a robust inflatable material such as a reinforced silicone rubber bag which is defined to have a main inflation portion which will lie inside the main line tubular structure in use, and an inflatable arm portion which lies inside the extension tubular structure in use.

To assemble the bag assembly and the cured in place lining unit, the inflation assembly is deflated and the arm is pushed inwardly of the main bag so as to be inverted therein. The main bag in this condition is positioned inside the main

tubular structure which by this time will have been impregnated with a curable resin, and the main bag and arm are inflated so that the arm everts through the extension tubular structure. The inflation assembly is then deflated again, and the arm is again inverted into the inside of the main bag, but this time the extension tubular structure is also inverted inside the inflatable arm. In this condition, the combined assembly and the lining carried thereby are introduced into the appropriate pipeline or passageway, with the inverted arm and extension tubular structure in register with the lateral pipe and then the bag assembly is reinflated which causes the main tubular structure to be inflated against the main pipe on opposite sides of the lateral, and the extension tubular structure to be everted into the lateral and against the lateral surface. This condition is maintained whilst the resin is caused or allowed to cure. When curing has been completed, and the lining assumes a rigid condition, the bag is again deflated and simply removed from the now remaining in place lining.

It is preferred that the resin should be of the ambient cure type which means that it will cure with the passage of time, which may be quite short, a matter of an hour or two, so that no external curing initiation means is required. It is of course possible to use resins which require cure initiation such as heat cure resins, light cure, ultrasonic and so on, but when other than ambient cure resin is utilised, extra means must be provided on site for initiating the cure which increases the cost of the process.

The inflation bag assembly may be designed to permit the flow of liquid along the main pipeline or passageway whilst the bag is inflated. To this end the inflation bag may be provided with a central core tube through which liquid can pass. The advantage of this is that when the bag is inflated

inside the main pipe, the liquid which normally flows through the pipe, for example sewage, can continue to flow through the inflated bag assembly and there will be no requirement therefore to divert the flow whilst the operation is taking place.

An embodiment of the present invention will now be described, by way of example, with reference to the accompanying diagrammatic drawings, wherein:-

Fig. 1 shows a sectional elevation an underground sewer pipe with a lateral connected thereto, and equipment for applying a lining in accordance with the invention;

Fig. 2 shows the arrangement of Fig. 1 with the lining in position;

Fig. 3 is an enlarged view in cross sectional elevation showing the positioning of the lining when inflated as in Fig. 2;

Fig. 4 is a view similar to Fig. 3, but showing the lining when deflated as in Fig. 1;

Fig. 5 is a perspective view of the lining assembly when in the Fig. 3 condition;

Fig. 6 is an exploded perspective view illustrating the method of assembly of the lining; and

Fig. 7 is a cross sectional view showing the lining in position in the pipeline or passageway.

Referring to the drawings, in Fig. 1 an underground main sewer 10 is illustrated, and it is joined by a lateral pipe

12.

The requirement is that the region 13 of the lateral/main pipe connection is to be lined with a cured in place liner. In accordance with the embodiment of the invention the liner is fabricated and tailored to fit the region 13 so as to line a portion of the lateral where it joins the main pipe 10, and also to line the main pipe to opposite sides of the lateral.

In Fig. 1 an installation apparatus is illustrated and comprises a tractor 14 of any suitable configuration to which is connected an umbilical cord 16 which may include a television camera cable and air and water supplies as appropriate. In this example, the tractor is connected to a coupling 16 which is rotatable, and a clamping and release device 18 connects to the lining assembly 20. By movement of the tractor 14, controlled typically from ground level, the lining assembly 20 can be moved into position, and in this connection it can also be rotated by rotating the coupling 16 so that as required the lining assembly 20 is in correct register with the lateral 12, a part of which is to be lined.

In the arrangement of Fig. 1, the lining assembly is shown deflated, but under the control of the operator at ground level, the assembly 20 can be inflated to the Fig. 2 position in which a portion of the main pipe to opposite sides of the lateral is lined with a cured in place tubular lining structure and an adjacent portion of the lateral 12 is also lined with an extension cured in place liner.

In this example the resin which is used is an ambient cure resin, and the condition shown in Fig. 2 is held until curing of the resin takes place. When curing has been completed sufficiently, the assembly 20 is deflated or more particularly an inflation bag thereof is deflated, and the

bag can then simply be pulled clear of the rigid lining which is left in place.

Figs. 3 and 4 show the arrangement in more particular detail to facilitate understanding.

Referring to Fig. 3, the cured in place liner comprises a main pipe tubular structure 22 which comprises at least one layer of resin absorbent material cured with the curable synthetic resin, and an extension cured in place tubular structure 24 which lies on the lateral 12. Extension tubular structure 24 is provided with an inner end collar 26 which abuts the inner surface of the tubular structure 22 and may be connected thereto, so that the tubular portion 24 projects through an aperture 26 in the main tubular structure 22. The length of the extension 24 is selected depending upon the length of the lateral 12 to be lined, but the main function of this lining assembly is to line the region of the connection in between the lateral and the main pipe.

Inside the lining is an inflation bag 28 for the suitable inflation material such as reinforced silicone rubber, and the bag has an arm 30 extending therefrom which performs the inflation of the extension tube 24 as will be understood.

At the ends of the main portion of the bag which inflates the main tubular structure 22, it has openings which are clamped around an infeed sleeve 32 in the case of the left-hand end, and a locking plug 34 in the case of the right-hand end.

The sleeve 32 is utilised for the injection of air under pressure and indicated by arrows 34 whereby the bag 28 may be inflated to the condition shown.

Fig. 4 shows the arrangement wherein the bag and the lining

applied thereto are in the deflated condition in which the assembly can be moved into position as shown in Fig. 1.

The extension tubular structure 24 is inverted along with the arm 30 of the bag so as to lie inwardly of the tubular structure 22. When the arrangement shown in Fig. 4 is inflated by introducing for example air under pressure, the assembly inflates to the condition shown in Fig. 3 and is held in this condition until curing is completed.

Figs. 5 and 6 show slightly more detail concerning the assembly of the lining and the bag.

As shown in Figs. 6, the main tubular structure 22 provided with the aperture 26 is arranged to have the extension 24 which has its collar 26 placed inside of same so that the extension tube 24 projects through the aperture 26 as shown in Fig. 6.

Next, the bag 28 is introduced into the inside of the liner and is inflated as shown in Fig. 5 so that the arm 30 in being inflated lies inside the extension tube 24. The bag 28 is now deflated, and the arm 30 is inverted to the position shown in Fig. 4 and at the same time the extension tube 24 is also inverted with the arm 30 so that the Fig. 4 condition is reached and the assembly can be placed in the main pipe 10 as shown in Fig. 1.

As mentioned above, inflation when the assembly 20 is appropriately registered with the lateral 12 results in the Fig. 3 position being achieved.

The absorbent material of the liner may be any suitable such as fibrous felt material, and it is preferred that ambient cure resin should be used as explained herein. The felt is

soaked in the resin both in the main tubular structure 22 and in the extension 24.

Any suitable inflation medium can be used for inflating the bag 28, and it may be hot or cold. Air or water can be used.

The bag 28 preferably is undersize in relation to the felt liner so that when it is deflated it can be readily pulled out.

It can be arranged that flow through of the medium which normally flows in the pipe 10 can be achieved by for example as shown in Fig. 3 providing that a core tube as shown in dotted lines and illustrated by reference 50 could extend through the bag and provide a route for the flow of sewage through the inflated bag.

It is preferred that a minimum shrinkage resin be utilised and suitable resins are epoxy resins and neopentylglycol.

The lining according to the embodiment is particularly useful for application to the region of where a lateral meets a main pipeline, and it has particular application where a lining pipe has previously been applied along the length of the main pipe and the lateral connection has been re-established, and where the re-establishment of the lateral connection is less than satisfactory. The lining can therefore be applied as a repair to a previous lining operation, or it can of course be applied directly to the existing surfaces for forming an appropriate seal which may indeed be in advance of a subsequent lining operation.

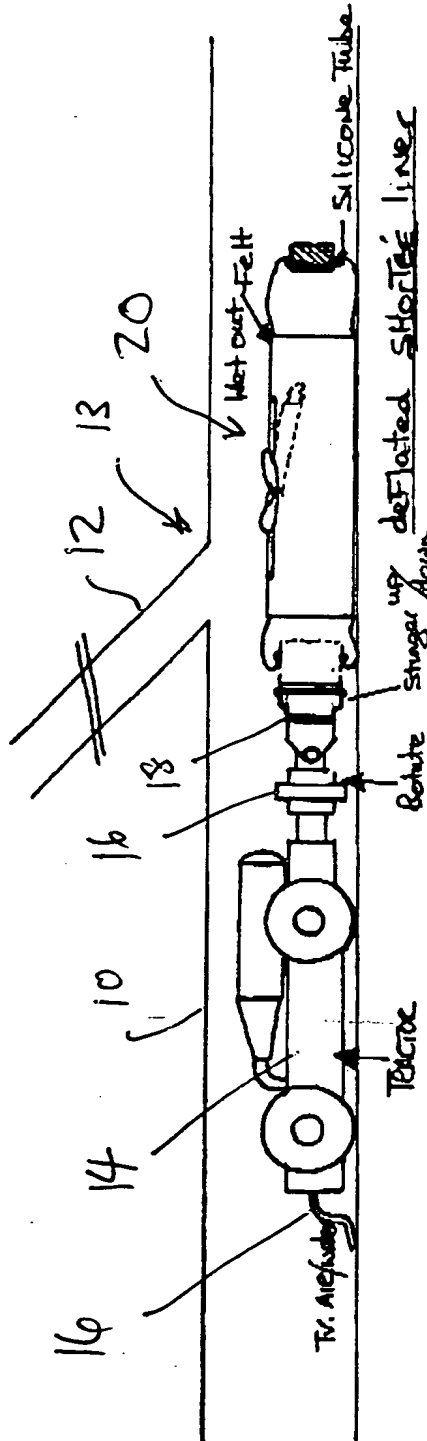
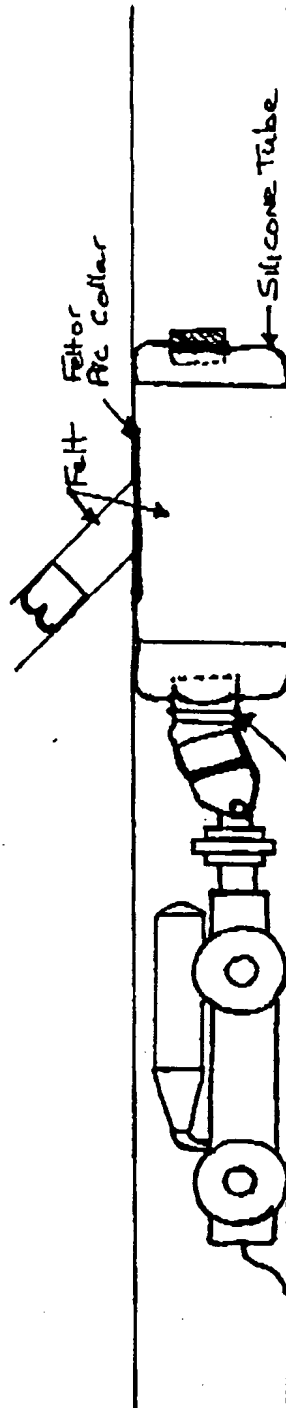


Fig. 4


$$\sqrt{2517}$$

Inflated Shoes in Position

Air oe

Used back. - with valued
personal merchandise
- can be pulled out

Shoetee' Peain:

Shortliner/lateral in one operation

plans to do
road work -
new bridge

flaw through wood
beamer collars

V Taylor. Lee Wood

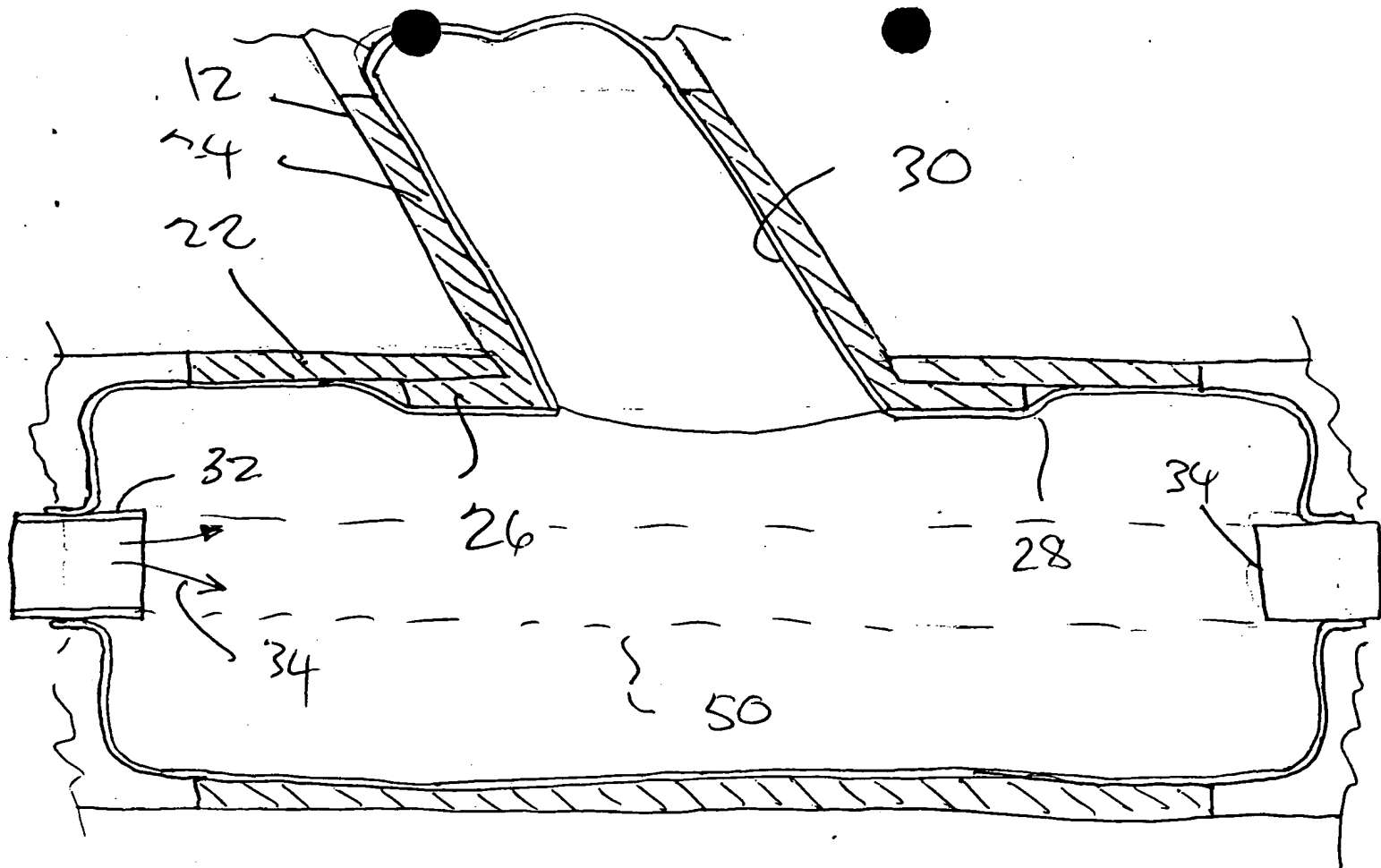


FIG. 3

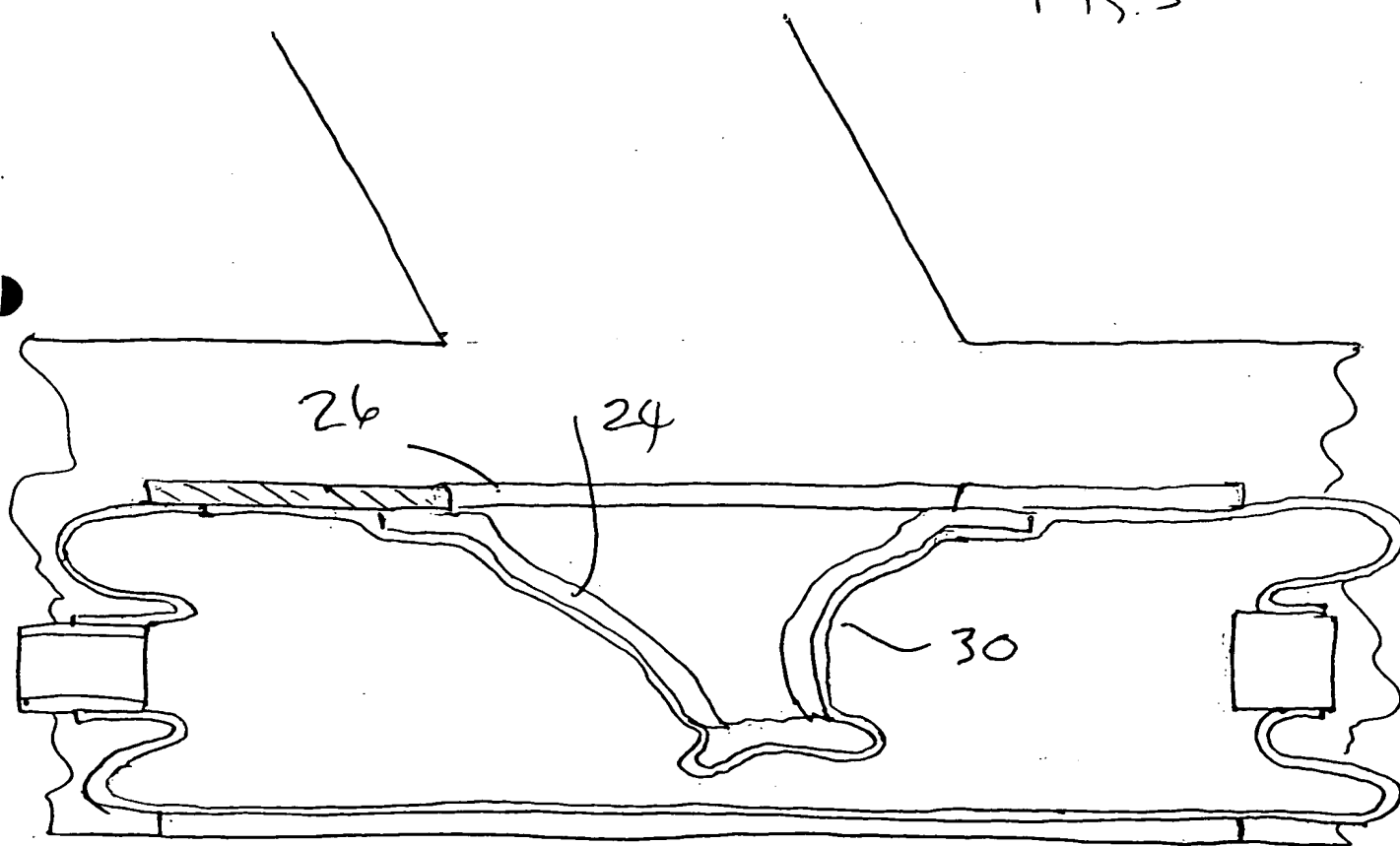
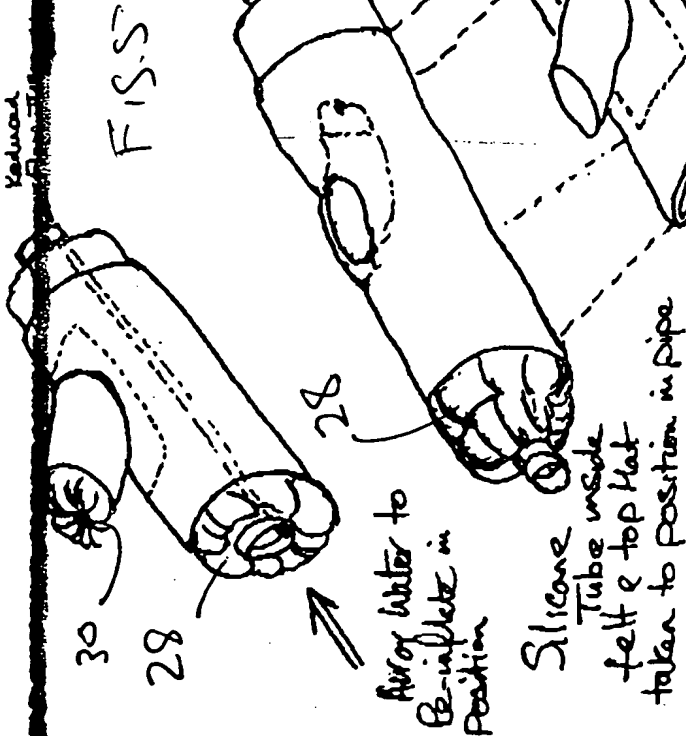
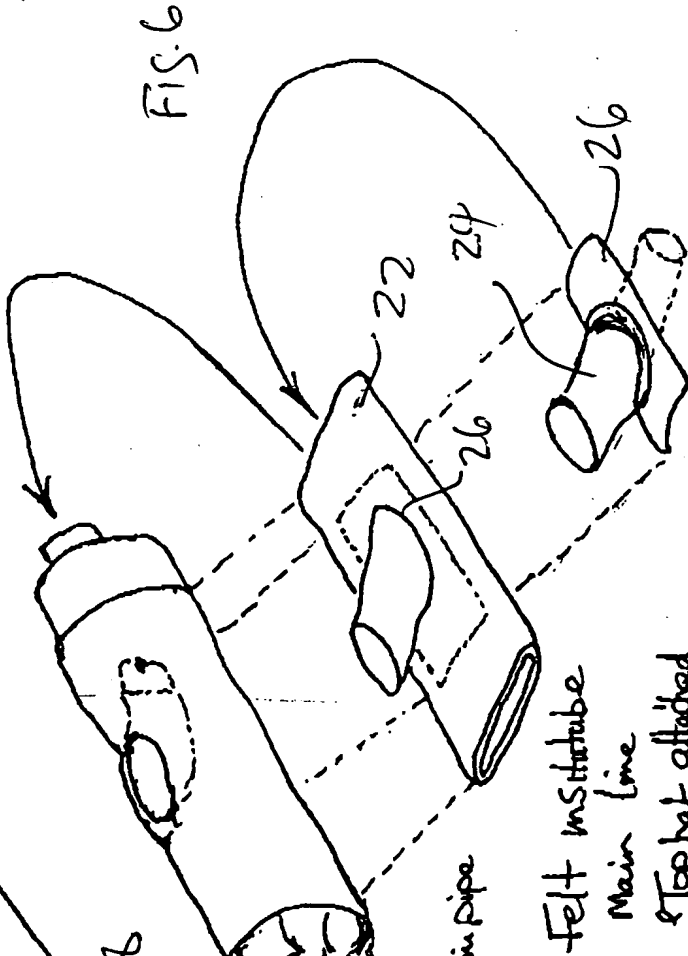


FIG. 4



Main Pipe
Felt

FIG. 7



Felt top hat with
lateral felt attached

SHOREE' Repair System without Re-opening Connection

Longer tube seal - outside
under seal

Hand. MPg
main body
main body
main body

Not possible to
use

V. Taylor / Chieftain